

Perioperative outcomes and type of anesthesia in hip surgical patients: An evidence based review

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Abstract

Over the last decades the demand for hip surgery, be it elective or in a traumatic setting, has greatly increased and is projected to expand even further. Concurrent with demographic changes the affected population is burdened by an increase in average comorbidity and serious complications. It has been suggested that the choice of anesthesia not only affects the surgery setting but also the perioperative outcome as a whole. Therefore different approaches and anesthetic techniques have been developed to offer individual anesthetic and analgesic care to hip surgery patients. Recent studies on comparative effectiveness utilizing population based data have given us a novel insight on anesthetic practice and outcome, showing favorable results in the usage of regional vs general anesthesia. In this review we aim to give an overview of anesthetic techniques in use for hip surgery and their impact on perioperative outcome. While there still remains a scarcity of data investigating perioperative outcomes and anesthesia, most studies concur on a positive outcome in overall mortality, thromboembolic events, blood loss and transfusion requirements when comparing regional to gener-

al anesthesia. Much of the currently available evidence suggests that a comprehensive medical approach with emphasis on regional anesthesia can prove beneficial to patients and the health care system.

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Key words: Perioperative outcome; Regional anesthesia; Neuraxial anesthesia; Hip arthroplasty; Hip fracture

Core tip: Recent studies on comparative effectiveness utilizing population based data have given us a novel insight on anesthetic practice and outcome, showing favorable results in the usage of regional vs. general anesthesia. In this review we aim to give an overview of anesthetic techniques in use for hip surgery and their impact on perioperative outcome. While there still remains a scarcity of data investigating perioperative outcomes and anesthesia, most studies concur on a positive outcome in overall mortality, thromboembolic events, blood loss and transfusion requirements when comparing regional to general anesthesia.

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INTRODUCTION

The increasing demand for hip arthroplasties over the last decades has sparked the creation of new and innovative anesthetic techniques and analgesic pathways with the goal to support best possible outcomes among this frequently elderly patient population. As a result, today different perioperative treatment pathways are available to physicians and their patients. In this context, the focus

has shifted to techniques based on regional anesthetic and analgesic techniques. This trajectory has been fueled by a number of advantages including effective, long-lasting and focused pain control, decreased need for systemic analgesics and earlier mobilization^[1]. While traditional views of anesthetic interventions have seen them in a more supportive role, allowing for surgery to take place and to alleviate pain postoperatively, an increasing body of literature has highlighted numerous beneficial effects of the use of regional anesthesia beyond the outcome of analgesia. Following this context, the use of regional compared to general anesthesia has been associated with beneficial results such as a lower incidence of mortality, reduced blood loss, thromboembolic events, cardiopulmonary complications, infections and favorable economic outcomes. However, evidence remains rare and there exists a paucity of publications focusing on comparatively reviewing perioperative outcomes among different types of anesthesia in hip surgical patients.

In this manuscript we will focus on the discussion of available types of anesthesia in the hip surgical patients and discuss their epidemiologic distribution. We aim to present and discuss common perioperative complications and evaluate the literature with respect to different anesthetic and analgesic techniques and their impact on these outcomes, including medical and economic factors.

EPIDEMIOLOGY OF HIP SURGERY AND ANESTHESIA TYPES

Surgeries involving the hip joint have dramatically increased over time and are expected to continue to rise in incidence within the coming decades. Fueling these trends, among other factors, are their high success rate both in elective as well as in traumatic settings and the fact that the target population, including the elderly is rapidly expanding.

It is estimated that by 2030 the demand for primary total hip arthroplasties in the United States will grow by 174% to 572000. Equally, the need for total hip revisions is projected to more than double to 137% in the same time frame^[2]. Based on demographic changes and trends in the decades to come, the annual rate of hip fractures has been projected to increase worldwide from 1.66 million in 1990 to 6.26 million in the year 2050^[3]. This is of special concern as of all osteoporotic fractures, hip fractures have been identified as the most expensive fracture type as measured by hospitalization costs^[4]. In addition, compounding the associated burden on the health care system exerted by the sheer volume alone, recent trend data are suggesting an increase in the average comorbidity burden and incidence of many serious complications among hip surgical patients^[5]. Therefore, any intervention that may impact on perioperative outcomes is bound to profoundly affect the public health of entire countries.

Epidemiologic information on the utilization of various types of anesthesia in hip surgical patients is more difficult to come by, as such information is not easily re-

trievable from data collection constructs. However, newer and more detailed databases have afforded researchers a rare glimpse of current anesthetic practice on a national level. A recent analysis of population based data, which included 382236 patient records undergoing primary hip or knee arthroplasty in the United States, showed that approximately 11% were performed solely under neuraxial, 14.2% under combined neuraxial-general and 74.8% under general anesthesia^[6]. This shows that even today, despite a trend to regional anesthesia, the majority of operations in the United States are carried out using solely general anesthesia. These percentages differ greatly between hospitals and likely among countries. While reasons for these findings have to remain speculative at this time, the choice of anesthesia might be based in part on historic developments and local or personal preferences. Similar disparities have been reported for the anesthetic care of hip fracture patients^[7]. Information on the use of peripheral nerve blocks in hip arthroplasty patients is even scarcer, but it is likely that the proportion of patients receiving such interventions remains low.

ANESTHETIC AND ANALGESIC TECHNIQUES FOR HIP SURGERY- BENEFITS AND PITFALLS

Despite some conflicting reports, a growing number of studies indicate that neuraxial anesthesia may prove beneficial to patients undergoing major joint replacement^[8-13]. However, and as mentioned previously, neuraxial anesthetic techniques remain widely underutilized on a national level. Reasons for this underutilization remain speculative but include a number of practical and perception based variables. As with all medical interventions, risks and benefits have to be taken into account when applying anesthetic and analgesic techniques in the context of ones practice. Below follows a brief discussion of commonly utilized approaches.

Surveys conducted with orthopedic surgeons noted primarily the perceived delay to achieve surgical readiness and lack of reliability as hindering to the wider acceptance of regional anesthesia. Still most surgeons queried stated to understand the benefits and they are supportive of the use of these methods^[14]. One of the factors why many patients and physicians might be reluctant to use neuraxial anesthesia is the fear of urinary retention and bladder catheterization. Contrary to prior belief it has been shown that patients undergoing hip arthroplasty have a low risk of urinary retention after neuraxial anesthesia and there has been no significant difference compared to general anesthesia^[15].

The risk of epidural/spinal hematoma formation is also frequently quoted as a concern, although this event is arguably rare. In a series of over 100000 patients undergoing orthopedic surgery with neuraxial anesthesia only 8 patients out of 97 patients reporting neurologic deficits were found to have epidural blood or gas collec-

tion. Of these affected individuals, all patients were using at least one potentially coagulation-impairing medication, but only one took an antiplatelet drug. In this series no patient sustained lasting nerve damage. This data suggests a slightly higher risk of complication than in an obstetric surgery setting, where patients are younger and healthier^[16]. Furthermore, it has been shown that peripheral nerve blocks are safe to use even in patients requiring thromboprophylaxis after joint arthroplasty. In approximately 7000 procedures among patients receiving warfarin, aspirin, fondaparinux, dalteparin and enoxaparin no perineural hematomas have been recorded in continuous lumbar plexus, femoral and continuous or single sciatic blocks^[17]. The general neurological complication risk of a central nerve blockade has been reported to lie below 0.04% and the rate of neuropathy after peripheral nerve block below 3%, with even less leading to permanent nerve damage. In fact, only one such case was reported in a review of 16 studies after peripheral nerve block with sample sizes ranging from 20 to 10309 blocks^[18].

A number of specific regional anesthetic procedures have been described, all with advantages and pitfalls. The psoas compartment block has been described as analgesically potent as an epidural technique during hip surgery, but reports caution regarding the possibility of severe complications, with the main risk being intrathecal or intravascular application of cardiotoxic doses of local anesthetics. With the advanced use of ultrasound however, these deep blocks may become even safer and their role in an intraoperative setting during hip surgery will have to be further evaluated^[19]. Due to the perceived risk involved in epidural, spinal or lumbar plexus blocks under anticoagulants, the femoral block has been developed as a possible alternative and has shown promising results considering postoperative analgesia, but has been criticized as an impediment to early postoperative ambulation^[20]. Some data suggest that a 4-d continuous lumbar plexus block may be compatible with successful postoperative ambulation. Recent studies did not have enough power though, to show statistical significant superiority compared to overnight use^[21]. Further, it has to be noted that under peripheral nerve block, for example a continuous lumbar plexus block, the risk of postoperative falls seems to be increased compared to non-continuous or no block used in patients with major lower extremity orthopedic surgery. However, the attributable risk of 1.7% seems to be within expectable range after major orthopedic surgery^[22].

In keeping with the trend of delivering anesthetic potency as close to the source of pain as possible, investigators have studied if pain could be reduced in minimally invasive hip arthroplasty patients receiving spinal anesthesia and an epicapsular catheter delivering ropivacaine to the wound. This approach showed a statistically significant reduction in postoperative morphine intake compared to administration of a placebo agent^[23]. To date, only few trials have shown corresponding results either by one-time local injection or continuous applica-

tion, highlighting the fact that near-wound infiltration techniques warrant further studies for optimization. Due to the early stage of these techniques, no standard approaches or guidelines have been defined to date^[24]. But many different approaches to regional anesthesia have shown promising results in postoperative pain reduction^[25].

In trying to provide guidance on best practices for hip surgical patients, the PROSPECT workgroup, focusing on procedure specific postoperative pain management, has recommended the use of peripheral nerve blocks as the primary choice for postoperative pain management in patients undergoing total hip arthroplasty, followed by spinal or epidural anesthesia depending on risk factors and comorbidities. The newer local infiltration techniques still warranted a grade A recommendation, if applicable for postoperative pain management. Even though the need to identify the proper intraoperative anesthetic method is focused on the consideration of the comorbidities of an individual patient and postoperative analgesia is therefore considered to be a secondary concern^[26].

ANESTHESIA TYPE AND PERIOPERATIVE OUTCOMES

While traditionally viewed as a means to provide surgical conditions, increasing evidence suggests that the choice of anesthesia significantly impacts on perioperative outcomes and thus may be viewed as a major component in an attempt to optimize patient care. Below follows a brief summary of the available evidence in respect to a number of important endpoints.

In-hospital mortality and 30-d mortality

Utilizing data from the UK collected between the years 2003 and 2011, a retrospective analysis of 90-d mortality in total hip replacements for osteoarthritis identified 4 major modifiable clinical factors for an improved outcome: A posterior surgical approach, mechanical and chemical thromboembolic prophylaxis and spinal anesthesia. Positive changes in management of the procedures could be shown as a steady decrease in 90-d mortality from 0.56% in 2003 to 0.29% in 2011^[27]. On the contrary, preexisting factors such as advanced age, male gender and a history of cardiorespiratory disease were associated with an increased risk of mortality within thirty days after elective hip arthroplasty^[28,29]. Interestingly, a new study evaluating the impact of the type of anesthesia on joint arthroplasty patients in the US, identified beneficial effects on major complications including 30-d mortality among all age groups of patients irrespective of comorbidity status, thus supporting the use of neuraxial anesthesia in all patient groups. Arguably though, the positive effect size was larger among older, sicker patients with cardiopulmonary diseases compared with younger, healthier patients^[30].

Further, a population based comparative effectiveness

study has shown a trend of reduction in 30-d mortality in hip arthroplasty with neuraxial compared to general anesthesia alone, with respective mortality rates of 0.2% and 0.3%^[6]. This mentioned positive effect of neuraxial anesthesia could also be shown in patients after hip fracture, a procedure typically affecting an elderly population^[7]. Meta-analyses have shown that spinal anesthesia is associated with significantly reduced early mortality, fewer incidents of deep vein thrombosis, less acute postoperative confusion, a tendency to fewer myocardial infarctions, fewer cases of pneumonia, fatal pulmonary embolism and postoperative hypoxia. In this population general anesthesia and respiratory diseases were identified as significant predictor of morbidity^[31].

Partially due to the fact that patients after traumatic injury are struggling with a number of contributing complications, this patient population suffers from a significantly higher mortality risk. In recent studies 30-d mortality has been reported as high as 13.3% and 3-6 mo mortality at around 15.8% in geriatric patients after hip fracture surgery. Indicators for this included advanced age, male gender, nursing home or facility residence, poor preoperative walking capacity, poor activities of daily living, higher ASA grading, poor mental state, multiple comorbidities, dementia or cognitive impairment, diabetes, cancer and cardiac disease. This extensive comorbidity burden helps to explain an overall mortality within 2 years of up to 34.5%^[32].

In hip fracture patients, trials noted a beneficial outcome in patients receiving regional anesthesia, with the main benefit lying in reduced 1-mo mortality and incidence of deep vein thrombosis^[13]. A recent comparative effectiveness trial of general versus regional anesthesia in hip fracture patients documented an in-hospital mortality rate of 2.4%. There were lower adjusted odds of mortality and pulmonary complications in patients receiving regional anesthesia. The rate of patients operated on with regional anesthesia was however noted to be at only 29%. In the subgroup analysis, regional anesthesia, *i.e.*, neuraxial, proved to be especially beneficial in patients with intertrochanteric fractures but no significant benefit in patients with femoral neck fractures could be shown^[7].

Of interest may be that among elderly patients undergoing hip or knee surgery neither general nor regional anesthesia does seem to contribute to impairment of cognitive and functional competence^[33].

Blood loss and transfusion need

For many years it has been repeatedly noted, that the type of anesthesia significantly impacts on intra and perioperative blood loss. These effects have primarily been attributed to hemodynamic differences, with lower and more stable blood pressures achieved through regional anesthesia resulting in less blood loss^[34]. Others have suggested a negative effect of general anesthesia utilizing nitrous oxide in the anesthetic gas mix to hinder erythropoiesis during endogenous recovery of red blood cells as a contributing factor^[35]. Studies showed favorable results

pairing spinal anesthesia to general anesthesia, noting a reduction of blood loss and transfusion requirement, as well as higher postoperative hemoglobin levels on days 1 and 2^[36]. Since these differences have been reported to occur even in similar systemic blood pressure anesthesia, some authors have suggested differences in the distribution of blood flow caused by spontaneous versus positive pressure ventilation^[37]. Especially in patients undergoing total hip replacement the use of neuraxial anesthesia has shown a reduction in blood loss as well as transfusion rates^[38]. The posterior lumbar plexus block has also been shown to be associated with reduced perioperative blood loss, perhaps in part due to its hemodynamic stability evoking pain control benefits and related decrease in sympathetic discharge^[39].

Researchers have speculated that hypothermia in patients might contribute to coagulopathies and might have an impact on perioperative blood loss. While some studies seem to affirm these effects, others have failed to show significant differences in normothermic to hypothermic patients. Until further studies have been conducted it seems safe to strive for normothermic surgical patients^[40]. Anesthesia generally affects body temperature, though neuraxial anesthesia seems to impair thermoregulatory control less than general anesthesia^[41].

All in all, the reduction in blood loss and transfusion requirement associated with neuraxial anesthesia is one of the best established concepts. A previously discussed comparative effectiveness analyses showed a significant difference in blood product transfusion with a 14% reduction in neuraxial versus general anesthesia. Also neuraxial anesthesia, even in combination with general anesthesia, showed beneficial outcomes with an increased risk for transfusions (odds ratio 1.4) after total hip arthroplasties for general anesthesia alone when compared to combined neuraxial/general anesthesia^[6].

Thromboembolic events

A number of pre-existing risk factors that have been shown to be associated with the development of thromboembolic events after hip surgery include a history of prior venous thromboembolism, obesity, delayed ambulation and female sex. Factors associated with lower risk could be identified in Asian/Pacific Islander ethnicity, the use of pneumatic compression among non-obese patients after surgery and extended thromboprophylaxis after hospital discharge. With these predisposing factors in mind some chemical markers have helped to identify high-risk patients, including elevated plasma D-Dimer and hyperlipidemia^[42,43].

Many studies have shown differences in thromboembolic risks comparing the use of general versus neuraxial anesthesia^[44]. Some authors suggest that the systemic effect of local anesthetics, as is seen during epidural anesthesia, might also lower surgery induced hypercoagulation in patients, leading to the aforementioned favorable difference in thromboembolic events. In patients undergoing epidural anesthesia after major orthopedic surgery

coagulation parameters were reported as not significantly altered from baseline^[45]. Observational studies have failed to this day to show differences in homeostatic markers undergoing general or neuraxial anesthesia, leaving the reasons for the observed clinical differences to be discussed and studied^[46].

Cardiopulmonary complications

The most frequent causes of death in modern joint replacement surgery are related to cardiopulmonary complications, even when excluding pulmonary embolism^[47].

From a cardiovascular perspective, it has been shown that the use of general anesthesia in combination with an epidural block increased the probability of patients experiencing clinical significant hypotension during anesthetic induction as compared to patients receiving either anesthesia alone. Still, no differences in heart rate or frequency of bradycardia have been observed^[35]. Recent population based data have failed to show differences in the risk for myocardial infarction in patients receiving general or neuraxial anesthesia. However, a 13% reduction in risk for non-ischemic cardiac events such as arrhythmias was noted^[6].

From a pulmonary perspective, regional anesthesia has been shown to be the preferable type of anesthesia in hip fracture patients with COPD and seems to be also associated with less pulmonary complications in all hip fracture patients^[7,48]. In patients undergoing total hip arthroplasty the use of general anesthesia *vs* neuraxial anesthesia showed a favorable outcome in respect to pulmonary complication risk with an adjusted odds ratio of 3.34. Since this significant beneficial effect could not be shown when a combination of neuraxial and general anesthesia was used, the reduced need for airway instrumentation and mechanical ventilation leading to less risk for aspiration, pneumonia or atelectasis might be possible underlying factors. Additionally, the reduction in postoperative opioid use might be a further reason for reduced pulmonary compromise and reduced utilization of critical care services^[6,49].

Infections

Surgical site infections are feared complications associated with significant morbidity and mortality^[50]. After adjustment for influencing factors, the odds of surgery site infections have been reported 2.21 times higher in patients receiving general anesthesia when compared to epidural or spinal anesthesia^[51]. The overall rate of infections (including surgical site and systemic) in elective hip surgery has been shown to be significantly increased with an adjusted odds ratio of 1.45 when comparing general anesthesia with neuraxial anesthesia alone^[6].

Some explanation for the aforementioned effects may be, that in-vitro and in-vivo experiments showed local anesthetics to modulate inflammatory response. Since epidural administration of local anesthetics leads to blood levels close to intravenous application, a systemic effect of these local anesthetics has to be considered.

There have been beneficial reports of systemic use of local anesthetics in sterile inflammation. However, it has been hypothesized, that with bacterial contamination this might lead to an increased risk of infection^[52].

Therefore it has been questioned whether neuraxial anesthesia is safe in patients with pre-existing infections such as infected prosthesis. Studies showed, that in these settings there was only a minimal risk of central nervous infections based on clinical criteria^[53]. Furthermore there has been no difference noted in cell-mediated or humoral immune response comparing spinal or general anesthesia^[54].

Economic outcomes

The international trend to reduce length of stay in surgical patients also applies to hip surgery. With multi-modal anesthesia, minimal invasive-surgery and home rehabilitation it has been shown that up to 44.4% of patients following total hip arthroplasty can be discharged within 24 h. Many patients can be discharged with indwelling peripheral nerve catheters and up to three-quarters of these patients do not require outpatient or home nursing care. Negative predictive factors for early discharge seem to be female gender, increasing age, increasing estimated blood loss and ASA III or IV^[55].

Concerns that complicated procedures may raise operating costs can be addressed by strategy and structural changes in the perioperative process, as has been shown in using an induction room in which pre-operative neuraxial anesthesia is being performed adjacent to the operating room^[56]. In contrast to perceived delays total hip replacement surgery operating times were significantly reduced in patients receiving regional anesthesia^[12]. Some studies argue that spinal anesthesia is associated with a benefit reflected in significant cost-reduction both in anesthesia times and recovery compared to general anesthesia in total hip or knee replacement operations^[57]. When studying population data, results suggest a lower incidence of increased cost in neuraxial patients combined with a lower risk for prolonged length of stay^[6]. In addition to lower complication rates and decreased resource utilization associated with the latter (as expressed in lower intensive care unit utilization and need for mechanical ventilation), economic benefits achieved with neuraxial anesthesia seem to make a sound economic argument^[49].

CONCLUSION

Randomized controlled trials on the differential impact of the type of anesthesia on outcomes are rare, underpowered and often present single-institutional data from specialized institutions. Meta-analyses and population based comparative effectiveness studies however, have shown that regional anesthesia seemingly improves perioperative outcomes in hip surgical patients. Most studies concur on positive outcome in overall mortality, thromboembolic events, blood loss and transfusion requirements. Despite some criticisms of the retrospective

nature of such analyses and those associated with methodological limitations, the evidence suggest that regional anesthesia is widely underused but could be a major factor in reducing medical and economic adverse outcomes.

While the reasons for these findings have to remain speculative to a certain extent, future investigations into the mechanisms of benefits observed with regional over general anesthesia may convince more clinicians of the benefits that could be gained by employing low cost and safe interventions in the form of regional techniques. Certainly, given the fact that only a small minority of patients currently receive regional anesthesia in some form, an increase in utilization could have profound effects on the health care system as a whole. Concluding, much of the currently available evidence suggests that a comprehensive medical approach with emphasis on regional anesthesia can prove beneficial to patients and the health care system.

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